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Technical Tips Following 850 Consecutive One Anastomosis Gastric Bypass (OAGB) Patients

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ABSTRACT

Background: The surgical procedure One Anastomosis Gastric Bypass (OAGB) has become widely used worldwide. Since its inception, many modifications have been introduced to improve results.

Objectives: The primary aim of this study was to share the modifications that we have introduced to our OAGB technique after reflecting on the problems and complications we have faced during the evolution of this procedure in our unit.

Method: A total of 850 patients who underwent OAGB under the same surgical team at two different hospitals in the United Kingdom were displayed according to demography and comorbidities. All complications were reviewed and analysed to instigate the changes in our technique.

Results: There were 756 (89%) primary and 94 (11%) revisional procedures. There were 596 females (70.11%) and 254 males (29.89%) in our study group. The body mass index range was 32–84 and the mean was 45. The pre-operative weight range was 89–274 kg and the mean was 126.4 kg.

Conclusions: With experience and reflecting on our complications we have modified our surgical approach, and these alterations have helped us to adopt OAGB as the mainstream bariatric procedure. We want to share our experience with the bariatric community for the benefit of patient care.

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INTRODUCTION

Globally, obesity has been on the rise for the last two decades. This increase has wide-ranging implications for general health and affects people's quality of life.[1] In 1997, Rutledge[2] described a gastric bypass technique that became known as the 'mini-gastric bypass'. This technique was modified by Carbajo et al. in 2005.[3] One anastomosis gastric bypass (OAGB) has gained popularity among bariatric surgeons worldwide, but some have raised concerns due to its association with the development of bile reflux gastritis, marginal ulcers, and cancer.[4]

Our aim is to share our surgical experience of this procedure and, more importantly, to describe the technical modifications that we adopted over time in response to the complications that we faced.

MATERIALS AND METHODS

This is a retrospective study of 850 patients who underwent OAGB to combat their obesity and related comorbidities between March 1, 2014 and March 31, 2022. The decision regarding bariatric surgical intervention was compatible with guidelines and protocols that are followed by the United Kingdom's National Health Service (NHS). The surgical team discussed with each patient all the details of the surgical procedures, including expectations, benefits and risks.

The bariatric team performed the OAGB procedure on these patients as a primary, second-stage, or revisional procedure at two hospitals in the United Kingdom(**Table 1**). Patient characteristics are shown in **Table 2**. Upper gastrointestinal endoscopies were performed on patients who had upper gastrointestinal symptoms, gastro-oesophageal reflux disease, or a history of previous gastro-duodenal problems. Patients were usually discharged on the second day after surgery and were followed up two

Table 1.
Procedure Types

Procedure Type	N (%)
Primary OAGB	756 (88.9)
Sleeve gastrectomy revision to OAGB	31 (3.6)
Band revision to OAGB	22 (2.5)
First stage sleeve then second stage OAGB	41 (4.8)

OAGB, one anastomosis gastric bypass.

Table 2.
Patient Characteristics

Characteristics	Mean ± Standard Deviation
N	850
Female	596
Age (years)	42 ± 9.1
Body mass index (kg/m^2)	45.2 ± 8.4
Weight (kg)	126.4 ± 4.1

weeks later, then after one, three, and six months, and then yearly for two years. All patients received vitamin supplements, in line with British Obesity and Metabolic Surgery Society guidelines.[5]

In this study, we analysed and learned from our complications, and instigated the necessary changes to our technique that reduced our complications rates (**Table 3**).

Surgical Technique and Modifications

The Roux-en-Y gastric bypass (RYGB) has been the gold standard in bariatric surgery since 1952, yet there is no real standardization of the technique. Bariatric surgery colleagues across the globe have been modifying the procedure to provide ideal solutions for bariatric patients, hence the variations.[6] We have seen many versions of the RYGB: short micro pouch, long macro pouch, distal and proximal limbs gastric bypass with variable Roux limb length, or the standard 150 cm limb length.[7] In our practice and experience, we regard the OAGB as the natural, most recent evolution of the original RYGB. The OAGB follows the principles of the original RYGB, but the anatomy is modified, with the aim of achieving better results.

We started bariatric surgery in our unit September 1, 1999. Since then, we have adopted different types of bariatric surgery, including gastric bypass, sleeve gastrectomy, and gastric band. Now that we are more experienced, we offer all types of revision bariatric surgery.

However, after we had performed more than 1,000 RYGB procedures over a 10 year period, we realized that we required a modification or a new procedure for our patients due to a variety of factors. One was weight recurrence, which is a testimony to the failure of the whole purpose of surgery. Others were the requirement for emergency operations to resolve internal hernias, even after closure of the mesenteric defect; problems associated with jejuno-jejunostomy; and our inability to treat reactive hypoglycaemia. Below we explain the changes we made to the procedure to combat these difficulties.

Table 3.
Complication Types, Incidence, and Resolution Measures

Complications	Incidence	Corrective Measure
Hepatic Failure	2 (0.2%)	Shortening limb length, revisional anastomosis
Diarrhea	5 (0.6%)	Shortening limb length, reversal of anastomosis
Bile reflux	36 (4.2%)	Hiatal exploration & repair, Roux-en-Y gastric bypass, jeujuno-jeujunostomy
Obstruction	3 (0.35%)	Conversion to Roux-en-Y gastric bypass
Bleeding	3 (0.35%)	Exploration & bleeding control
Stomal ulcer	21 (2.47%)	Biliary diversion, gastro-jejunal, Roux-en-Y
Malnutrition	3 (0.3%)	Nutrition support, reversal to normal anatomy
Leak	1 (0.11%)	Re-exploration, lavage & repair
Mortality	0	
Morbidity Total	74 (8.7%)	

The Pouch

When we started performing OAGB, we adopted the concept of the I-shaped pouch. The first staple line was placed horizontally at the incisura angularis, guided by the crow's feet. We soon realized that this produced a short pouch, especially if a side-to-side stapled anastomosis was performed as this would decrease the length of the pouch by 20–30%.

In the last five years, we have adopted the concept of the 'hockey stick' (J-shaped) pouch. To produce this shape, the first staple is placed perpendicularly to the lesser curvature, 2 cm proximal to the pylorus, with the use of the 45-mm purple staple (Medtronic), making sure to take as much as possible of the stomach to the left of this perpendicular staple while ensuring that this staple does not transect the stomach (**Figure 1**).

The second staple is another 45-mm purple staple (Medtronic), which is placed horizontally, parallel to the lesser curve, and incorporates the full length of the first 45-mm staple. At this stage, a 34F calibration tube is inserted to guide the rest of the staples, which are applied up to the gastro-oesophageal junction.

Creation of the pouch is a meticulous step that requires attention to detail. All posterior attachments of the pouch in the omental bursa should be divided; this procedure helps to produce a pouch with a homogeneous diameter so that the pouch is attached eventually only to the blood supply on the lesser curvature. Utmost care must be taken not to injure the left gastric pedicle.

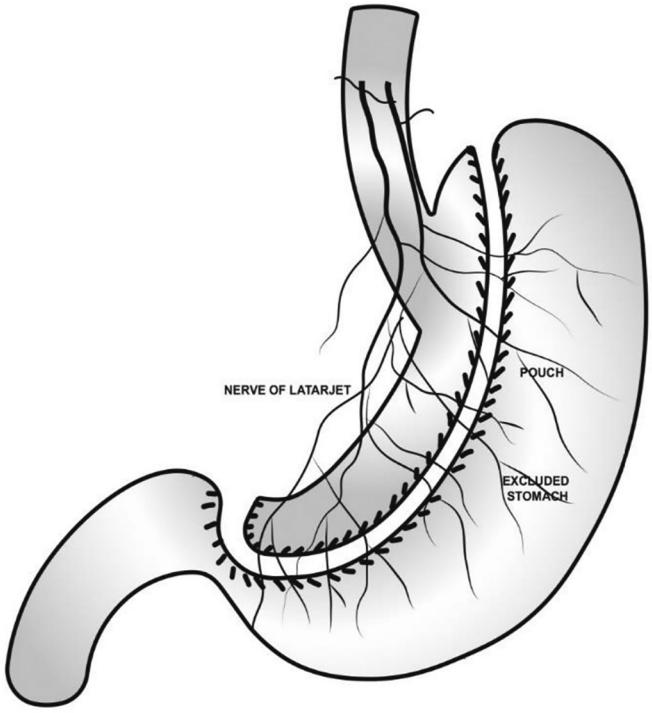

Figure 1. Diagram of our surgical technique.

At the gastro-oesophageal junction it is important to display the whole length of the left crus and that the oesophagus lies comfortably in the abdomen without the need for downward traction. Any visible hiatal hernia should be dissected and repaired, although sometimes it is small, and release of the hiatus is sufficient to make sure that the oesophagus is in the abdominal cavity.

We take extra care to ensure that the pouch is not twisted, and that all of the staple line lies to the left of the midline. The first two staples must be purple because of the thick gastric wall in the antral area. If any split occurs around the staple line in this area, the staple line is enforced with Vicryl suture. To ensure that the pouch performs the desired function it must be made narrow enough to only accommodate 34F-sized bougie from the gastro-oesophageal junction to the gastro-jejunal anastomosis.

The Anastomosis

Initially, when we performed OAGB with the I-pouch concept, in which the first staple was placed through the incisura angularis, the anastomosis was stapled posteriorly, side-to-side, with the application of 45-mm tan staples (Medtronic), and the gap at the anastomosis was closed with Vicryl sutures.

Subsequently, we realized that the use of this method decreased the length of the pouch by 20–30% and led to the occurrence of bile reflux. Additionally, there were a few problems with obstruction at the anastomosis. These problems may have been functional rather than anatomical. To solve these problems, we adopted the end-to-side anastomosis design. In this design, the anastomosis is hand-sewn at the distal end of the pouch and the side of the jejunum hand sewn with two layers of Vicryl.

In our attempt to produce a long pouch, we adopted the concept of the hockey stick or also called J-shaped pouch. For this method, a side-to-side anastomosis is performed through the application of 45-mm tan staples (Medtronic) in the posterior wall of the pouch.

We make sure that the anastomosis is sufficiently wide to perform its function and lies horizontally. Also, we apply the staples of the anastomosis meticulously to make sure

that there is minimal, or no, gastric tissue between the two staple lines. We believe that the larger the amount of gastric tissue between the staple lines, the more is the occurrence of stomal ulceration due to tissue ischaemia. It is vital that this anastomosis lies transversely, without tension, and that there is no twist with the afferent limb clearly positioned on the left and the efferent limb on the right.

Protein-caloric Malnutrition (PCM)

Limb Length

During initial years of our performance of the OAGB, we adjusted a biliopancreatic limb of 200 cm as standard adding 50 cm for patients with a body mass index (BMI) of 50 or above, and another 50 cm for those with Type-2 diabetes. This meant that we had a cohort of patients who had biliopancreatic limbs of 3 m. We subsequently learned that this limb length led to complications of diarrhea, malnutrition, and liver decompensation. Hence, we changed our approach.

Our current protocol requires that the maximum length of the biliopancreatic limb is 150 cm. In patients with BMIs of 35–40, we produce a limb of length 130 cm, and in those with BMIs of 30–35, we adjust the biliopancreatic limb length to 100–120 cm.

This approach has eliminated the problems of diarrhea and malnutrition. Having said that we now check routinely that there is at least 3 m of small bowel distal to the anastomosis before we perform any gastro-jejunostomy.

Complications

Hepatic Decompensation (Failure)

Two patients (0.23%) developed hepatic decompensation. Both were treated during the early period of our series; both were female with BMIs above 50 and one of them was diabetic. Both patients had biliopancreatic limbs of 250–300 cm.

Both patients presented with abnormal liver function tests and persistent nausea. The first patient presented 6 months after surgery. Because at that time we had little experience with the operation, it took us a long time to reach the diagnosis, by which time this patient was jaundiced with established hepatic failure and low albumin levels. After a period of support that included laparoscopic insertion of a feeding tube into the gastric remnant, we reversed the OAGB to produce normal functioning anatomy with a gastro-gastrostomy and jejuno-jejunostomy. The patient recovered from the hepatic failure but gained weight.

The second patient presented 16 months after surgery. Due to our previous experience with a similar scenario, we acted earlier than we had in the first case and shortened the biliopancreatic limb to 80 cm. This patient recovered and maintained her weight loss.

It is very interesting that neither of these patients suffered diarrhea despite their hepatic failure and long biliopancreatic limbs, which we believe was the cause of their complication.

Currently we do not perform biliopancreatic limbs longer than 150 cm and we have a low threshold for shorter limbs, especially in cases in which, during surgery, the liver looks chronically diseased. We also suggest shorter biliopancreatic limbs for vegetarian patients and over the age of 60.

Diarrhea

Five patients (0.58%) developed a propensity for frequent loose stools, which interfered with their everyday lives, a year or more after the operation. The consistency and frequency of passing stool varied and none of them were malnourished, but the patients were unable to accommodate this change in their bowel habit while continuing with their previous everyday lives. We categorized these five patients as having intractable diarrhea and we offered them surgical revision. All these patients had biliopancreatic limbs of 200–250 cm. One of them had an efferent limb of 180 cm, while the other four had efferent limbs of more than 4 m.

One patient elected to reverse the OAGB to normal functional anatomy, while the other four patients responded well to the shortening of the biliopancreatic limbs. Now we follow the protocol to ensure that there is at least 3 m of efferent limb before we construct the gastro-jejunostomy.

Bile Reflux

We had 36 (4.23%) patients who required surgical intervention to resolve bile reflux complications. We experienced two types of presentation with bile reflux. The first was biliary gastritis, in which patients presented with epigastric discomfort, dyspepsia, and nausea. Gastroscopies in this group of patients revealed very inflamed gastric pouches, in which bile was pooling, and biopsies from the gastric wall showed reactive

gastritis. The second group presentation was in the form of frank bile volume regurgitation, especially when they lay flat or after they had eaten. Endoscopies in these patients showed bile pooling freely in the oesophagus and stomach. The main symptom among these patients was bilious volume regurgitation rather than other dyspeptic symptoms.

Even though we have tailored and modified the procedure over the years, we still do not know why some patients develop bile reflux or biliary gastritis and others do not. All these patients were investigated by gastroscopy and barium studies. All underwent revisional surgery in the form of hiatal exploration and repair of hiatus hernias, and complete biliary diversion through conversion of the anatomy to the RYGB, in which the Roux limb was made to be 40cm and the jejuno-jejunostomy was hand-sewn with two layers using Vicryl suture.

We found that performance of partial biliary diversion through the application of jejuno-jejunostomy only while leaving the configuration of the omega loop intact did not work with our patients. We consider that complete biliary diversion was required.

Of these 36 patients, 23 suffered pre-operative gastro-oesophageal reflux and for 19 of them, we repaired hiatus hernias during the primary OAGB procedure.

Our current standard technique is to make sure that there is at least 2–3 cm of esophagus in the abdominal cavity when we construct the pouch and, if there is any doubt, we have a very low threshold for hiatal exploration to mobilize the esophagus from the lower posterior mediastinum. We make sure that the pouch is narrow over a 34F bougie, we observe a low threshold for hiatal dissection, and we ensure that we produce a wide horizontal gastro-jejunostomy with no twist.

Obstruction

Three patients (0.35%) experienced anatomical or functional obstructions at the gastro-jejunostomy; all of these occurred after we had performed side-to-side stapled anastomosis with the I-pouch, which ended at the incisura. We believe that the obstructions were caused by the twist in the anatomy at the gastro-jejunal anastomosis, which was perpendicular. This problem disappeared after we changed the technique to end-to-side anastomosis and later adopted the J-shaped pouch with transverse side-to-side anastomosis. In our experience, under these circumstances, we believe revision to RYGB is the best option.

Bleeding

Three patients (0.35%) experienced considerable amounts of bleeding that required re-operation.

The first patient presented 5 days after surgery with haematemesis. The bleeding was at the site of the end-to-side gastro-jejunal anastomosis. This was diagnosed by gastroscopy subsequently during laparoscopy the anastomosis was opened, the bleeding point was secured, and the anastomosis was closed. This patient recovered well.

Another two patients presented with haemorrhagic shock within the first 6 hours after surgery. In both patients, the bleeding was from the posterior gastric vessel and both required conversion of laparoscopy into laparotomy due to poor visualisation and to obtain better access. Both patients recovered well.

Stomal Ulceration

We had 21 patients (3.41%) with stomal ulcers; 9 of them were in the first 100 patients in our series. Later, as our technique changed, the stomal ulcer became a rarity.

The exact etiology of stomal ulcers remains unclear to the surgical community. Smoking, the presence of H. pylori, gastric acid, and bile salts are all contributing factors, but we believe ischaemia of gastric tissue that is trapped between the staple lines plays a significant role. All our patients who developed stomal ulcers were smokers.

As we developed our technique, we learned to pay careful attention to minimize the amount of gastric tissue caught between the two staple lines at the gastro-jejunostomy. Currently if there is detectable ischaemic gastric tissue during surgery then we excise it and continue the anastomosis with use of the hand-sewn technique.

We emphasize patient education about the dangers of smoking, and we prescribe proton pump inhibitors (PPIs) routinely postoperatively to our patients for the first 6 months after surgery. We have found that these measures had considerably decreased the rate of development of stomal ulcers.

We operated on 12 patients for stomal ulcers. Four patients presented with perforated ulcers at 6, 11, 14, and 16 months after surgery. Three patients at laparoscopy had anterior perforation which was treated by omental patch and biliary diversion, so the afferent limb was transected just proximal to the gastro jejunostomy and joined by hand sewn anastomosis to the efferent limb 40 cm distal to the gastro jejunostomy with closure of the mesenteric gap. Basically, converting OAGB configuration to

RYGB. A fourth patient had a posterior perforation and it was necessary to redo the whole anastomosis and convert to an RYGB by resecting the gastro-jejunostomy including the ulcer, using the efferent limb as Roux limb and the afferent limb as biliopancreatic limb to reconstruct the RYGB.

Eight patients had elective surgery because their stomal ulcers were not healing despite intensive medical management. Two underwent complete biliary diversion, while in the other 6 patients, excision of the gastro-jejunostomy and construction of RYGB was required. All the ulcers eventually healed by the time of the 1-year follow-up.

Leak

In 1 patient (0.11%), a leak occurred. This patient had undergone a conversion of sleeve gastrectomy into an OAGB. The leak was from the upper part of the staple line, just below the gastro-oesophageal junction. This was managed using laparoscopic re-exploration, lavage, insertion of a drain, and 3 weeks of total parenteral nutrition. The patient recovered well and was discharged.

Malnutrition

Three patients (0.32%) experienced excessive weight loss, fatigue, and hypoalbuminemia. They did not have diarrhea, their liver function tests showed no gross impairment, and serum ammonia levels were normal. They were treated with the help of psychiatric support and total parenteral nutrition Two of these patients underwent reversal of the OAGB to normal functioning anatomy. The third patient also had a reversal of OAGB to sleeve gastrectomy.

DISCUSSION

The OAGB has achieved a reputation as a credible, favourable, and effective bariatric surgical procedure. In many bariatric units around the world, the OAGB is probably the most performed procedure and there is vast evidence of satisfactory outcomes in relation to total weight loss and resolution of comorbidities.

However, this procedure is not without problems. Some are short-term, others are long-term.[8] Here we have shared with the bariatric community our efforts to develop and modify the technique in our units, based on our audit and reflections on the complications with the difficulties we faced during our early and midterm experience. In order to achieve acceptable post-operative metabolic outcomes, various modifications have been made to the surgical techniques.[9]

Liver decompensation is a known complication after bariatric surgery, and mortality rates at some units have been up to 60% after RYGB.[10] However, dedicated studies of this phenomenon have not recorded high rates of its association with OAGB.[3] Early in our series we had 2 patients who developed hepatic failure. As our experience grew and we adjusted the biliopancreatic limb length, hepatic dysfunction did not occur again.

Some studies have found that PCM can be a problem after OAGB.[11] Refractory PCM has been reported to be commonly encountered during the postoperative period; however, the incidence among our patients was very low at 0.3%.

Based on our experience, currently we do not make afferent loop of more than 150 cm in our practice. We believe that the incidence of complications of OAGB such as malnutrition and hepatic impairment is related to the length of the bypassed small bowel. Therefore, this plays an integral role in the success of surgery. With no definitive consensus on the ideal limb length, many studies support our practice of restricting the afferent limb length to a maximum of 150 cm.[12] The final decision regarding this length also depends on the individual case scenario and the surgeon's experience.

In our study, 21 patients (2.47%) developed stomal ulcers after the procedure. A large study showed an incidence of 4% of stomal ulceration in their sample.[13] We believe that gastric wall ischaemia has a significant role in the development of these ulcers in addition to other factors such as smoking, taking steroids, and no-steroidal anti-inflammatory medications.[14]

There has been a debate over the duration of the use of PPIs after bariatric surgery. Many studies have been performed, in which the researchers have found support for the use of PPIs over periods that range from weeks to lifetimes. No consensus has yet been reached on the dosage of duration of PPI prophylaxis.[15] In our practice, we recommend the use of PPI prophylaxis for 6 months after surgery and we believe that this has contributed to the achievement of a low incidence of stomal ulcers in our series.

In 2018, a Delphi structured consensus recommended that simultaneous hiatoplasty should not be performed alongside OAGB.[16] We have adopted a very low threshold

for hiatal dissection in existing hiatus hernias and our policy is to have at least a 3-cm intra-abdominal length of esophagus.

A large UK-based study showed low mortality rates associated with OAGB of 0.14%.[17] These results were like those shown by the cumulative data held by the British Obesity and Metabolic Surgery Society. Among our large number of patients, none died. This finding supports the safety level that is associated with this surgical practice. Previous meta-analysis of OAGB procedures has yielded a complication rate of 3.4%;[18] for our study, the total complication rate was approximately 8.7% (74 patients) this includes our early experience when our practice was on the steep part of the learning curve.

We will report the impact of our technique on comorbidities in future publications.

CONCLUSION

We have been performing bariatric surgery since 1999. We gained extensive experience with the RYGB before we adopted the OAGB, and we feel adequate specific training and attention to detail is crucial to obtain the full potential of this procedure with low complications.

This study was focused on the technical development and evolution of OAGB in our unit and we hope our colleagues in the bariatric community will find it useful for the welfare of patients.

OAGB is an effective bariatric procedure that is efficient in managing morbid obesity with associated comorbidities and in improving patients' quality of life. Undoubtedly all surgeons require training, and they must climb a steep learning curve. More long-term studies are required among different centres to reach an acceptable technical standardisation.

Limitations

This study comprises of a single center data and experience. It is a retrospective study of prospectively collected data. The data collected is based on a procedure that was technically changing over the years in response to the problems we faced and hence our attempts to share with colleagues our humble experience of OAGB evolution in our practice.

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